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AK213B AK214S AK216R AK217S AK220R AK220S
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(56) Documents cited
US 4641065 A

(58) Field of search
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(54) Commutated moving-coil linear motor

(57) A moving-coil linear motor (10) is formed with a stator means (11) forming a guide (13) and having a permanent magnet array (14) having opposite poles alternately at constant intervals in longitudinal direction of the stator means, and a mover means (12) mounted on the stator means having moving coils (23, 23a, 23b) wound in bipolar system on cores (22, 22a, 22b) which are U-shaped in section. Positive and negative voltages are alternately applied from conducting strip 15 through brushes (25, 25a, 25b) to the moving coils of the mover means, while its U-shaped cores are opposed to the permanent magnet array, disposing the array between both leg portions of the U-shaped cores. The guide arrangement may follow a curved path and the arrangement used to operate curtains. Core and magnet locating means are disclosed.

Fig. 1

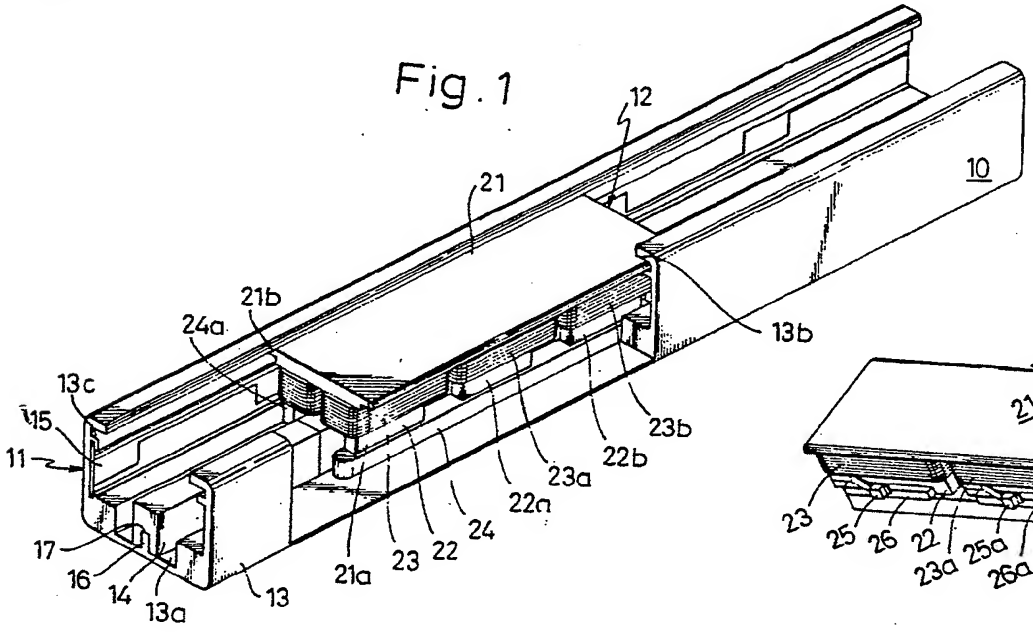

Fig. 2

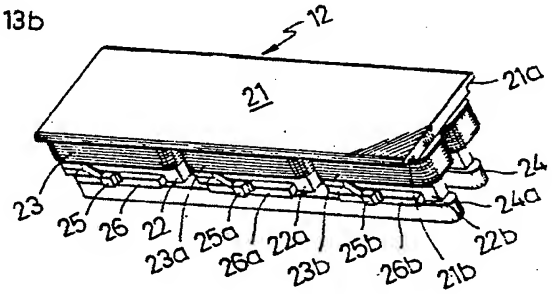

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Fig. 2

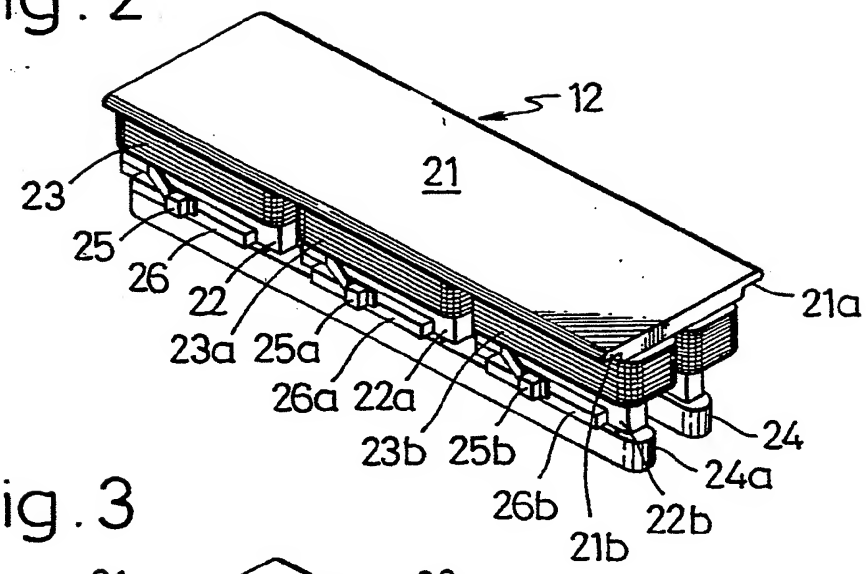


Fig. 3

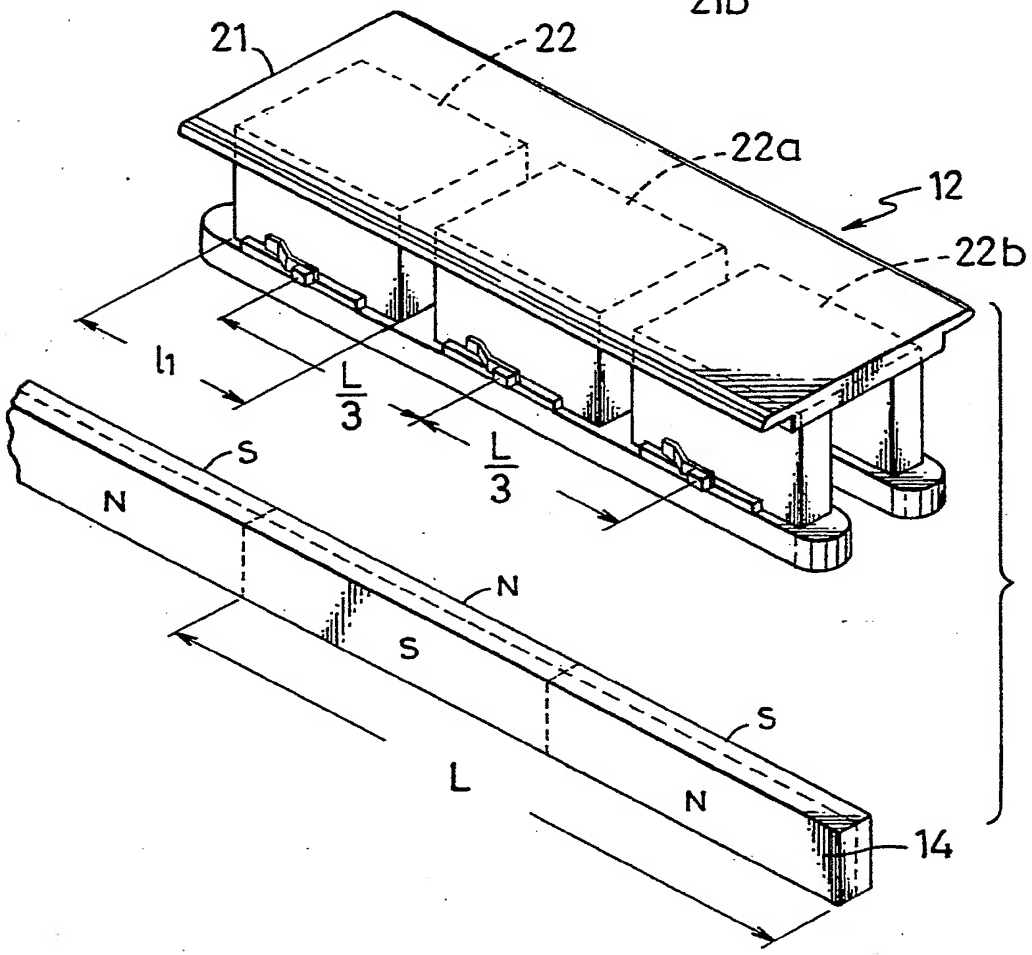


Fig. 7

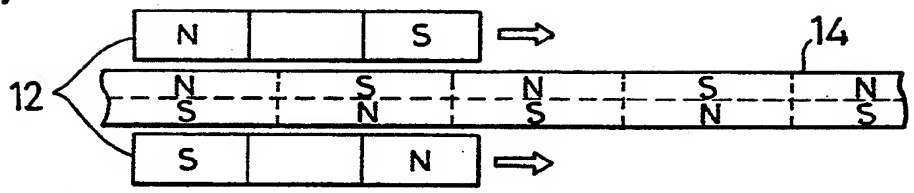


Fig. 8

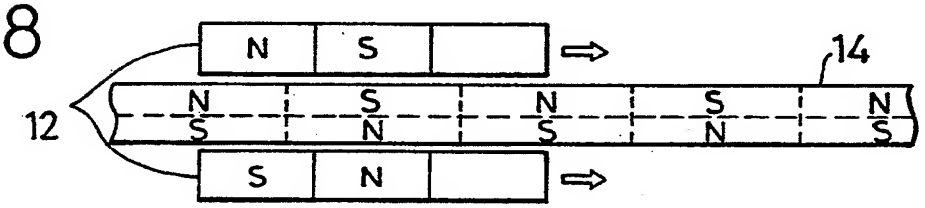


Fig. 9

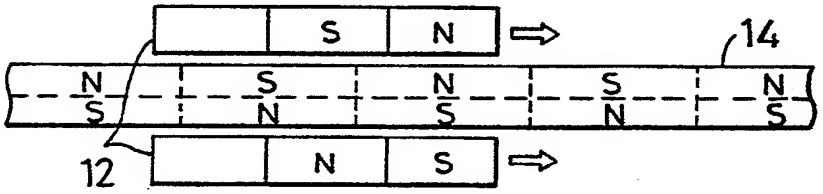


Fig. 10

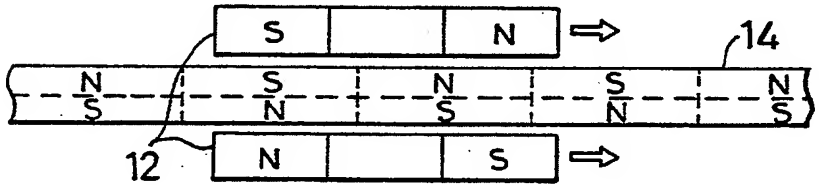


Fig. 11

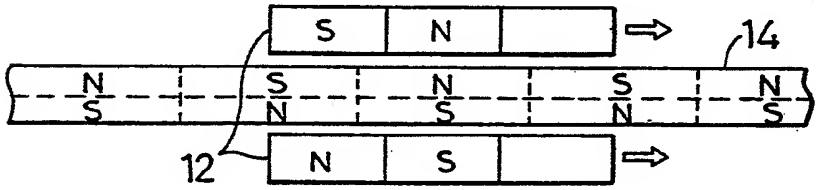


Fig. 12

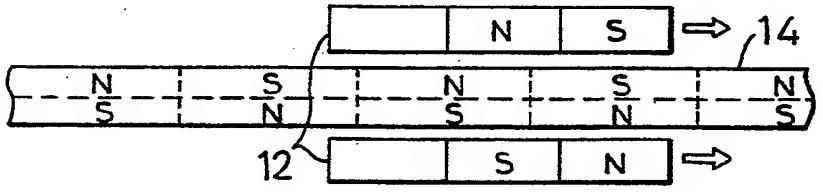


Fig.17

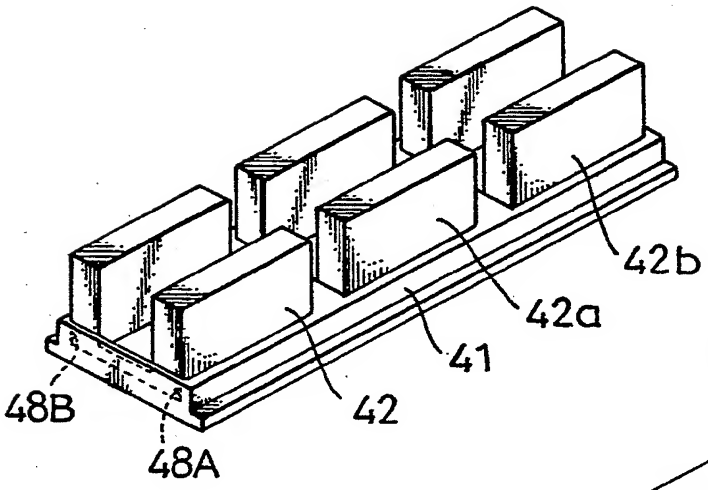


Fig.18

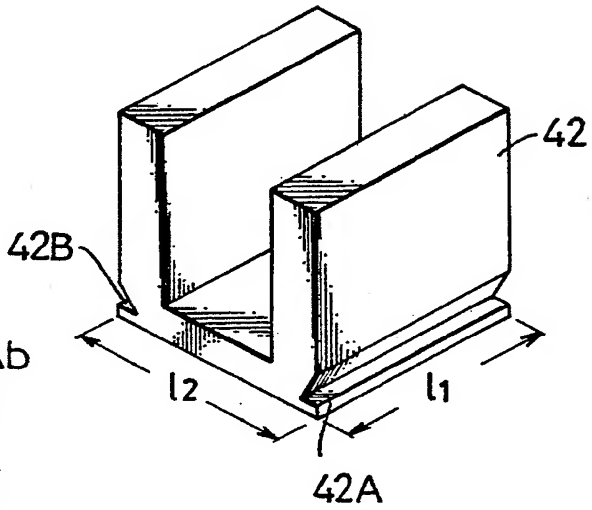


Fig.19

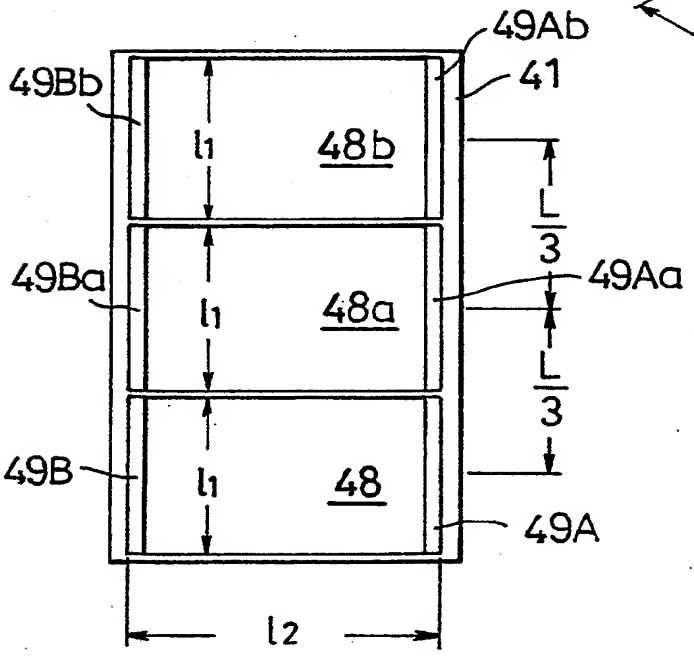


Fig.20

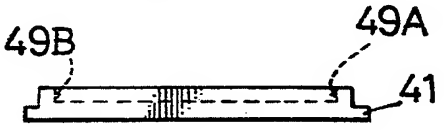
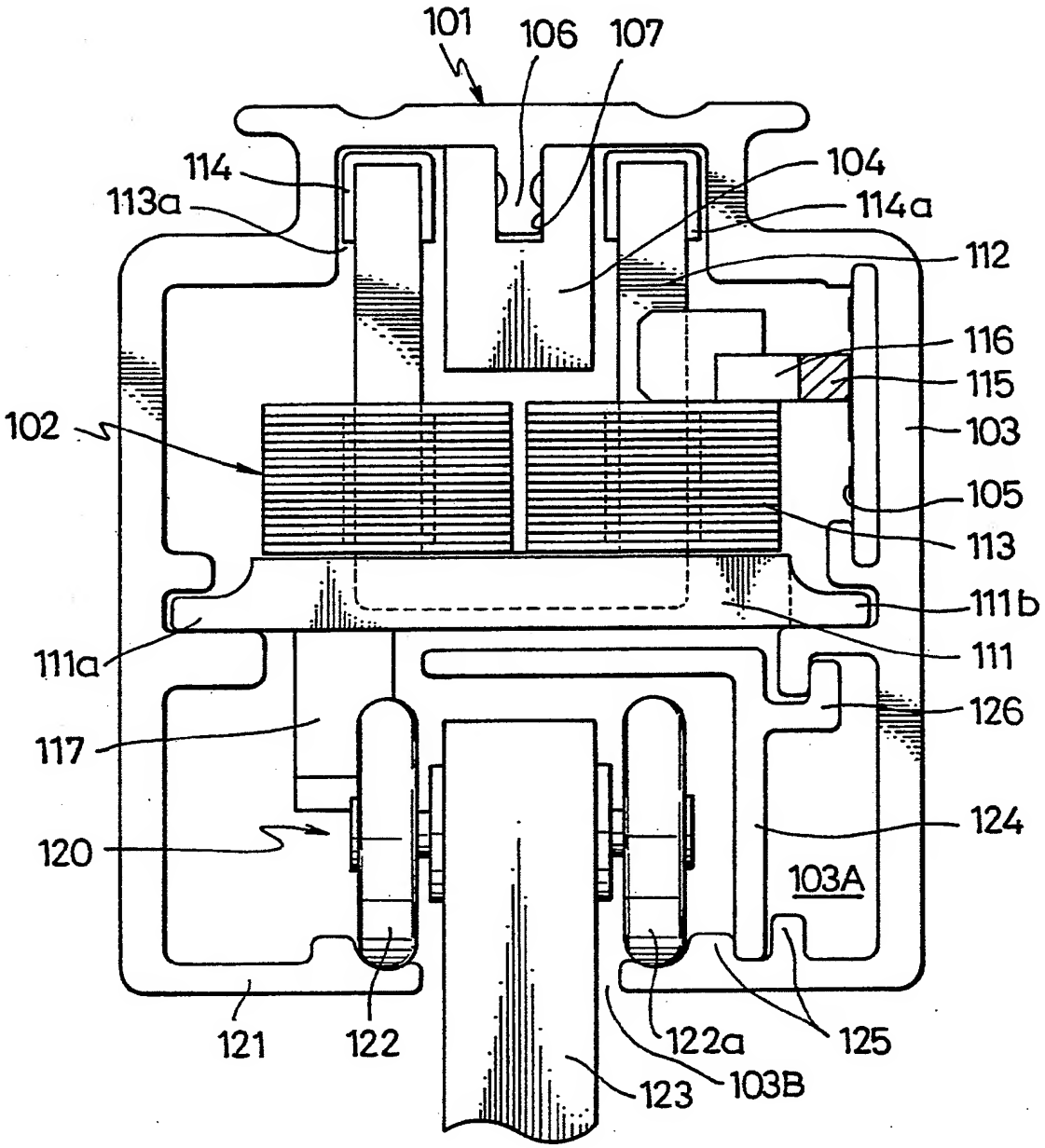


Fig. 22



This invention relates to moving-coil linear motors which are applicable to various carrying, conveying and transporting means.

The moving-coil linear motors of the kind referred to may be effectively contributive, for example, to remote-controlled or automated opening and closing of curtains as formed to be small and bilaterally shiftable within a guide frame with curtain rings, so as to be a carrying means for the curtains through the curtain rings.

The linear motors have been increasingly widely utilized as the carrying, conveying or transporting means in recent years, and are generally classified into moving-magnet type and moving-coil type. In U.S. Patent No. 4,633,108 of J. von der Heide et al, there has been shown a linear motor of the moving-magnet type in which a permanent magnet plate is disposed shiftable in magnetic gaps formed in magnetic circuits of a plurality of electromagnetic devices linearly disposed. In this moving-magnet linear motor, however, there has been a problem that the electromagnetic devices acting as a stator means are required to be always supplied with an electric power so that electromagnetic coils of the respective devices are always kept in heat generating state to increase heat generation.

movement. Since the motor of this reluctance type is relatively low in the torque, there involves a problem that the entire motor size has to be made larger in order that a larger torque is to be attained, in addition to an inherent drawback that the magnetic efficiency cannot be sufficiency increased due to the absence of any core. Further, the moving solenoid assembly is so formed as to surround the rail assembly, so that there is still another problem that any support member cannot be provided to the rail assembly at its intermediate position except for both end portions and an elongated rail assembly becomes insufficient in respect of support strength.

In the case of a further moving-coil linear motor disclosed in U.S. Patent No. 4,641,065 of Osamu Shibuki et al, a two-phase moving coil assembly U-shaped in section is mounted on a stator means of an array of plate-shaped permanent magnets magnetized to be opposite polarities in their thickness direction, so that the U-shaped coil assembly will enclosingly oppose substantially three consequtive side faces of the permanent magnets, and an exciting current is supplied to this moving coil assembly through brushes from a power feeding pattern provided along the permanent magnet array. An arrangement in which this linear motor of Shibuki et al is applied to curtain opening and closing has been disclosed in Japanese Utility Model Application Laid-Open Publication No. 1-103385 of Shigeru Sakagami et al, assignors to the same assignee as in the present case. In these linear motor and applied

A primary aim of the present invention is, therefore, to provide a moving-coil linear motor which is provided with cores in the moving coils to remarkably increase the magnetic flux density in the gap for extremely effective improvement in the magnetic efficiency, while still realizing dimensional minimization of the entire motor to a sufficiently satisfiable extent.

This aim of the present invention can be realized by a moving-coil linear motor in which a stator means including a permanent magnet array magnetized to have opposite poles in thickness direction and also in longitudinal direction of the array alternately at regular intervals is disposed to form a guide, and a mover means including moving three-phase coils is mounted on the stator means to be movable along the stator means through an electromagnetic force due to positive and negative voltages alternately applied through brushes to the moving coils from a power feed pattern provided on the stator means, characterized in that the moving coils are respectively wound in bipolar system on a core U-shaped in section, both leg portions of which U-shaped cores being opposed to the permanent magnet array disposed between the leg portions.

The invention will now be described in detail, by way of example, with reference to the drawings, in which:-

in the another aspect of FIG. 17;

FIG. 20 is a front elevation of the base of FIG. 19;

FIG. 21 is a perspective view of the array of permanent magnets in another working aspect in the linear motor according to the present invention;

FIG. 22 shows in a sectional view as magnified a working aspect in which the linear motor according to the present invention is applied to a carrier means for opening and closing curtains; and

FIG. 23 is a perspective view of the carrier means of FIG. 22.

While the present invention shall now be described with reference to the embodiments shown in the accompanying drawings, it should be appreciated that the intention is not to limit the present invention only to the embodiments shown but to rather include all modifications, alterations and equivalent arrangements possible within the scope of appended claims.

Referring to FIGS. 1 and 2, there is shown here an embodiment of the moving-coil linear motor according to the present invention, in which the linear motor 10 generally comprises a stator means 11 and a mover means 12. The stator means 11 comprises an elongated guide frame 13 substantially U-shaped in section, a permanent magnet array 14 extending substantially over the entire length of the frame 13 as disposed in recessed part 13a formed longitudinally in inner bottom wall of the guide

have a length L/3 in the longitudinal direction of the pattern 15.

The mover means 12 is formed in an electromagnetic device assembly of three-phase structure with respect to a flat plate-shaped base 21. Three cores 22, 22a and 22b respectively formed by a laminate of flat U-shaped iron plates are mounted to the base 21, preferably as seated in recesses made in the base, and coils 23, 23a and 23b are wound in bipolar system respectively on each of the cores 22, 22a and 22b, so as to form the moving coils of the mover means. Respective parallel leg portions of the U-shaped cores 22, 22a and 22b are disposed on both sides of the permanent magnet array 14 as disposed within the recessed part 13a of the guide frame 13 at extended ends of both legs so as to oppose the permanent magnet array 14 disposed between the core legs, while shoe members 24 and 24a preferably of an insulating material are mounted each across the three leg portions on each side of the array 14 throughout the three cores 22, 22a and 22b. These shoe members 24 and 24a are to be thus disposed each between one side face of the permanent magnet array 14 and opposing side wall of the recessed part 13a of the guide frame 13, so that a clearance between the one side face of the permanent magnet array 14 and the opposing side wall of the recessed part 13a can be prevented from becoming excessively large or small, and the leg portions of the cores 22, 22a and 22b are assured to be freely movable reciprocatingly in stable manner

15 in its width direction or in height direction of the side walls of the guide frame 13 (see broken line in FIG. 4), so that the positive and negative power voltages will be alternately applied through the brushes 25, 25a and 25b to the respective moving coils 23, 23a and 23b.

The operation of the foregoing moving-coil linear motor 10 according to the present invention shall be referred to here. Now, the exciting power is fed in any known manner from the power feed pattern 15 through the brushes 25, 25a and 25b to the respective three-phase moving coils 23, 23a and 23b which are wound in the bipolar system so as to be reverse directional at their respective coil portions wound on the leg portions of each core so that a current will be caused to flow, for example, in clockwise direction through one of such two coil portions but in counterclockwise through the other coil portion, in each of the coils 23, 23a and 23b. Accordingly, when one of the leg portions of each core is excited to be N-pole, the other leg portion is excited to be S-pole. Assuming here that the brushes 25, 25a and 25b of the mover means 12 sliding along the power feed pattern 15 are in contact therewith at three positions 01, 02 and 03 as shown in FIG. 4 by small double circles, then the mover means 12 will be at such position as in FIG. 5 where the current is fed to two moving coils 23 and 23b so that the leg portions of the their cores 22 and 22b will be of such polarities as shown in FIG. 5, whereby there is caused an electromagnetic repulsion occurred between

driven to move along the permanent magnet array 14, and eventually the mover means is slidingly moved along the guide frame 13 of the stator means 11. During such movement of the mover means 12, as has been briefly referred to, the mover means 12 is allowed to stably move along the stator means 11 without substantial lateral play, since the shoe members 24 and 24a mounted commonly to the cores 22, 22a and 22b are disposed between both side faces of the permanent magnet array 14 and both side wall faces of the recessed part 13a in the guide frame 13 while the side edges 21a and 21b of the base 21 are engaged in the guide grooves 13b and 13c of the frame 13. That is, it is effectively made possible to overcome any of such problem that the cores 22, 22a and 22b are caused to tilt or deviate with respect to the permanent magnet array 14 so as to collide therewith to impair the driving force given to the mover means 12 while physically damaging the array 14. More particularly, the mover means 12 of the linear motor 10 according to the present invention incorporates effectively the cores 22, 22a and 22b, so that the motor 10 can be remarkably improved in the magnetic efficiency and the driving force with respect to the mover means 12 can be also remarkably increased. Assuming here that the driving force to the mover means 12 may be limited to be of the same level as that in conventional coreless type linear motors, the motor may be sufficiently made smaller in size, as will be readily appreciated.

longitudinal direction of the base 41, and the cores 42, 42a and 42b are placed in the recesses 48, 48a and 48b in the base 41 with the projections 49A ... 49Bb snap-fitted into the engaging grooves 42A ... 42Bb.

In the moving-coil linear motor 10 according to the present invention (see FIG. 21), on the other hand, the motor may comprise as the stator means a permanent magnet array 54 made of a material freely curved, which material may be cut in a proper length for freely setting the longitudinal length of the array. For this type of the material, practically, a rubber magnet material may be employed. With this arrangement, the length of the permanent magnet array 54 and eventually of the stator means in its longitudinal direction can be set to be the most preferable in accordance with dimensional and the like conditions at installing position of the linear motor.

In the above arrangement of the linear motor of the present invention, further, the respective cores corresponding to the respective coils are divided so as to form mutually independent magnetic circuits, unlike an arrangement in which the cores are coupled by means of a magnetic member. For this reason, the base which supports these cores may be fabricated with a resilient member or the cores may be mutually coupled through flexible joints and, as will be appreciated by any skilled in the art, the linear motor readily can be made movable along a curved path.

103, so as to extend between the base 111 and the wheels 122a and the base 111 and the hanger 123, for preventing any foreign matter entering into upper part of the guide frame 103. Other constituents and their functions are substantially the same as those in the embodiment of FIGS. 1-3.

In the above described carrier means for the curtains with the linear motor of the present invention employed, a power fed through the power feeding pattern 105 and brushes 115 to the coils 113 (shown here only ones for one phase in FIGS. 22 and 23) with desired polarities in a state where curtain rings (not shown) are hung to the hanger 123, then the carrier means is caused to slide in desired direction along the longitudinal direction of the guide frame 103 so that the opening or closing of the curtains can be thereby realized. It should be appreciated that no weight of the curtains and so on is imparted to any other members disposed above the base 111 during the sliding movement of the carrier means so that the carrier means can be smoothly driven to slide in a relatively low load state.

mounted to said projection as spaced from both side walls in said recessed part.

4. A motor of claim 3 wherein said both leg parts of said cores have end portions disposed with a clearance between said permanent magnet array and said both side walls of said recessed part, and shoe members respectively mounted to each of said end portions of the cores.

5. A motor of claim 1 wherein said mover means further includes a flat plate-shaped base for mounting thereto said cores carrying said moving coils wound thereon, and said guide frame is substantially U-shaped in section and having in opposing inner wall surfaces a pair of guide grooves for guiding both side edges of said base.

6. A motor of claim 5 wherein said both side edges of said base are thinned.

7. A motor of claim 1 wherein said stator means comprises an elongated guide frame in which a chamber including an upper part and a lower part is defined, said upper part accommodating therein said mover means, said lower part accommodating therein a shifting means interlocked with said mover means and having in bottom wall a slit extending in longitudinal direction of said guide frame, and said mover means includes a plat plate-shaped base for mounting thereto said cores carrying said moving coils wound thereon, said base being provided with a connecting member for connecting the base to said shifting means which carrying wheels rollable along both